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ABSTRACT

The National Aeronautics and Space Administration (NASA) has produced a distance learning series of four 60-minute video programs with an accompanying Web site and companion teacher guide. This teacher guide accompanies the second video in the series. The story line of each program involves six ethnically diverse, inquisitive schoolchildren who meet in a treehouse. They seek the solution to a particular problem, and the NASA "Why?" Files series follows them through the steps of their investigation and final conclusion. In this program, the treehouse detectives learn that many of the neighborhoods in the city are experiencing a problem with dogs barking late at night and early in the morning. The program includes a visit by the treehouse friends to various NASA researchers, an audiologist, a veterinarian, and classroom teachers. Students learn about sound: what it is, how it is transmitted, and how people and animals hear. Students also learn about collecting and analyzing data. This teacher guide includes a program overview as well as science, mathematics, and educational technology concepts related to the National Standards. Each 15-minute program segment is described along with objectives, key vocabulary, suggestions for the most effective use of the videos and Web site in the classroom, and resources. In addition, each segment is accompanied by activities and worksheets. (PVD)

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ED 459 066

The NASA "Why?" Files
The Case of the Barking Dogs

Program 2 in the 2000-2001 Series

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The NASA "Why?" Files
whyfiles.larc.nasa.gov

Educator's Guide	
Teachers & Students	Grades 3-5

EP-2000-09-20-LaRC

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Teachers & Students	Grades 3-5

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Production of the NASA "Why?" Files is made possible by the generous support provided by AIAA Foundation; Busch Gardens, Williamsburg; Hampton City Public Schools; and the NASA Langley Research Center's Learning Technology Project and Aerospace Vehicle Systems Technology Program Office.

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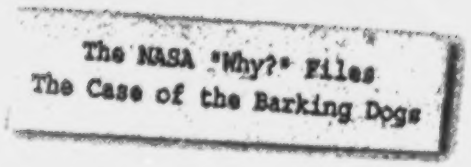
The American Institute of Aeronautics and Astronautics (AIAA) provides classroom mentors to educators who register for the NASA "Why?" Files. Every effort will be made to match a teacher with an AIAA member who will mentor the teacher either in person or by e-mail. To request a mentor, e-mail nasawhyfiles@aiaa.org or call Lisa Bacon at (703) 264-7527.

AIAA FOUNDATION

Contact the AIAA to get a classroom mentor at ***nasaconnect@aiaa.org.***



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Program Overview

In *The Case of the Barking Dogs*, the tree house detectives have yet another mystery to solve. Many of the neighborhoods in Big City are experiencing a problem with their pooches barking late at night and early in the morning. The barking is even affecting some of the tree house detectives. They have a big test soon and they need to get some sleep!

The tree house detectives visit their friend Dr. D, a retired science professor, for advise on where to start their investigation. With his direction, the tree house detectives go on many excursions to speak with various NASA Researchers, an audiologist, a veterinarian, and even their classroom teachers to get help solving the case. Along the way, they learn more about sound: what it is, how it is transmitted, and how people and animals hear. With a few clues from the local news station, KSNN (Kids Science News Network), the tree house detectives are able to use scientific inquiry and the scientific method to solve the mystery.

Tune in to see what is causing the neighborhood dogs to bark. Use your scientific investigation skills and "sound" reasoning to uncover the hilariously funny ending to the mystery!

National Math Standards (grades 3–5)

Standard	Segment 1	2	3	4
Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems		✖	✖	
Understand meanings of operations and how they relate to one another		✖	✖	
Compute fluently and make reasonable estimates		✖	✖	
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols		✖		
Use mathematical models to represent and understand quantitative relationships		✖		
Analyze change in various contexts		✖		
Geometry				
Specify location and describe spatial relationships using coordinate geometry and other representational systems				✖
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement		✖	✖	✖
Apply appropriate techniques, tools, and formulas to determine measurements		✖	✖	✖
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them	✖			
Select and use appropriate statistical methods to analyze data	✖	✖		
Connections				
Recognize and use connections among mathematical ideas		✖		
Recognize and apply mathematics in contexts outside of mathematics		✖		✖
Representation				
Create and use representations to organize, record, and communicate mathematical ideas	✖	✖		✖
Use representations to model and interpret physical, social, and mathematical phenomena		✖		✖

National Science Standards (grades k–4)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, orders, and organization	✖		✖	
Evidence, models, and explanations			✖	
Change, constancy, and measurement			✖	
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	✖		✖	
Understanding about scientific inquiry	✖		✖	
Physical Science (B)				
Properties of objects and materials			✖	
Position and motion of objects	✖		✖	
Life Science (C)				
Characteristics of organisms				
Organisms and their environments	✖		✖	
Science and Technology (E)				
Abilities of technological design	✖		✖	
Understanding about science and technology.	✖		✖	
Science in Personal and Social Perspective (F)				
Changes in environment	✖		✖	
Science and technology in local challenges				
History and Nature of Science (G)				
Science as a human endeavor	✖		✖	

National Science Standards (grades 5–8)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, order, and organization	✖		✖	
Evidence, models, and explanations			✖	
Change, constancy, and measurement			✖	
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	✖		✖	
Understandings about scientific inquiry	✖		✖	
Physical Science (B)				
Motion and forces			✖	
Transfer of energy	✖		✖	
Life Science (C)				
Regulation and behavior	✖		✖	
Science and Technology (E)				
Abilities of technological design	✖		✖	
Understanding about science and technology	✖		✖	
Science in Personal and Social Perspectives (F)				
Risks and benefits				
Science and technology in society	✖		✖	
History and Nature of Science (G)				
Science as a human endeavor	✖		✖	
Nature of science			✖	

National Educational Technology Standards (grades 3–5)

Performance Indicators for Technology-Literate Students

Standard	Segment 1	2	3	4
Basic Operations and Concepts				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Technology Communication Tools				
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	✖			✖
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	✖	✖		✖
Technology Research Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	✖			✖

The NASA "Why?" Files
The Case of the Barking Dogs

Segment 1

KSNN (Kids Science News Network) is encouraging dog owners to bring in their pooches at night so Big City residents can get some sleep. Several friends, known as the tree house detectives, are wondering what is causing the dogs in the neighborhood to bark. The tree house detectives are excited to begin their next case, *The Case of the Barking Dogs*. The children visit their neighbor, a retired science professor, who reviews the methods of science and emphasizes the importance of using the Scientific Method to solve problems. The children use the NASA "Why?" Files' web site to gather research on sound and visit their local museum to learn about vibrations and frequency. They use the Internet to send e-mails to local residents to determine which neighbors are having difficulty with barking dogs. A NASA Langley Research Center researcher shows the tree house detectives how to collect and analyze their data.

Objectives

Students will be able to

- learn the processes involved in solving problems by using the methods of science.
- make observations and inferences from hands-on experience.
- solve a problem by using the methods of science.
- analyze data by using a matrix board.
- discover how sound is created by performing experiments with vibration and frequency.
- explore the physics of sound such as vibration and pitch.
- discover how musical instruments create sound.
- discover and learn more about possible career choices by viewing the video and researching other careers.

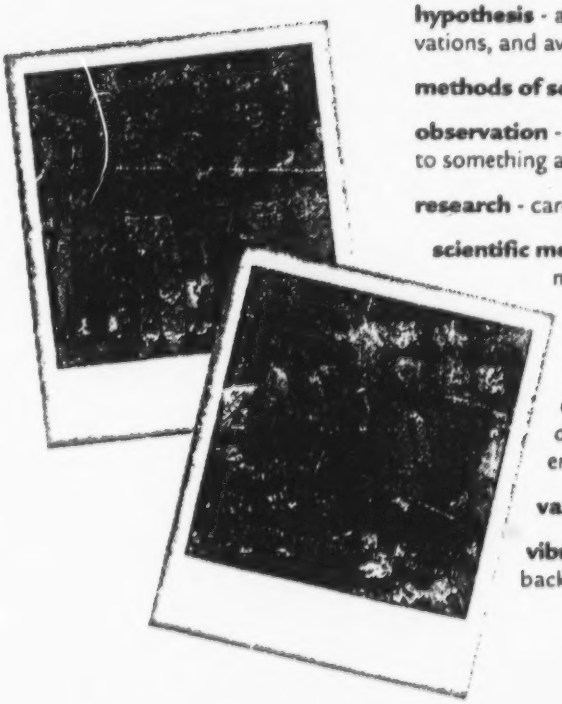
Vocabulary

conclusion - a judgment or decision reached after analyzing data

data - factual information, especially information organized for analysis or for making decisions

frequency - the number of vibrations per given amount of time

hypothesis - a testable prediction for a problem based on research, observations, and available data



methods of science - processes used in solving problems

observation - the act of systematically observing or paying careful attention to something and noting or recording what was observed

research - careful study or investigation of something

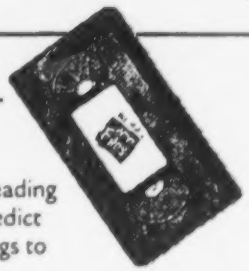
scientific method - the problem-solving procedures used by scientists that may or may not include the following basic steps: define the problem, make a hypothesis, test the hypothesis, analyze the results, and draw conclusions

scientist - a person who has special training and expertise/knowledge in the observation, identification, description, experimental investigation, and explanation of scientific facts or occurrences

variables - in an experiment, any factor that can change

vibrations - a rapid linear motion of a particle or elastic solid; a back and forth wave movement of sound

Video Component (15 min)



Before Viewing

Introduce the video to the students by reading its title and synopsis. Ask students to predict what they think might be causing the dogs to bark.

For students to better relate to the video and the terminology introduced in the first segment, the teacher may wish to perform the following pre-activities before viewing.

1. Introduce problem solving by discussing with the students the different ways that they solve problems in their daily lives
2. Introduce the scientific method as a problem-solving process/tool that scientists use to solve problems. Emphasize that the scientific method is not a step-by-step process but rather an ongoing process of gathering information, obtaining data, formulating and reformulating a hypothesis, and drawing conclusions. ***Note:*** *Many science educators today prefer the term "methods of science."*
3. From the web, download the Scientific Method Handout and use it to acquaint students with terminology and processes. This handout has a brief description of each part of the scientific method.
4. The Scientific Method Worksheet (p.15), for all grade levels, may be used as a practice sheet or a written assessment of the students' understanding of the scientific method.
5. To familiarize students with the methods of science, choose an experiment from the guide (Colorful Carnations, p. 16) or from the web (Color Mixing) for the students to perform. Have students write the steps of the experiment and then perform the procedure. We suggest this be a teacher-lead activity with a discussion of each step and an explanation of its relationship and relativity to the methods of science. Draw conclusions.
6. Make a predictions chart. Accept all answers, but help students to narrow focus if necessary. Do a K-W-L (What you **K**now, what you **W**ant to know, and what you have **L**earned) for various predictions. See the Matix Board Chart (p. 20).

After Viewing the Video

1. Discuss the questions that are asked at the end of the first segment.
   - Will the dogs continue to bark?
   - Are the tree house detectives asking the right questions?
   - Will the scientific method solve the problem?
2. Make a display of the Methods of Science Board (p. 14). Refer to the chart as the students go through the scientific method to reinforce that it is not a step-by-step process but rather an interdependent relationship.
3. Choose from the activities in this packet (p. 14-23) to help reinforce the concepts and objectives emphasized in this segment.

Careers

Museum Curator
Professor or Teacher
Scientist
Reporter
Computer Technician
Research Analyst
Detective

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Resources

Web Sites

NASA "Why?" Files Web Site
Official web site of the NASA "Why?" Files. Student, teacher, and parent friendly.
http://whyfiles.larc.nasa.gov

Books and Other References

Cole, Joanna: *The Magic School Bus Gets Programmed, A Book About Computers.* NY: Scholastic, Inc. (1999), ISBN 0590187317

Cole, Joanna and Linda Ward Beech: *The Magic School Bus In the Haunted Museum, A Book About Sound.* Scholastic Trade (1995), ISBN 0590484125

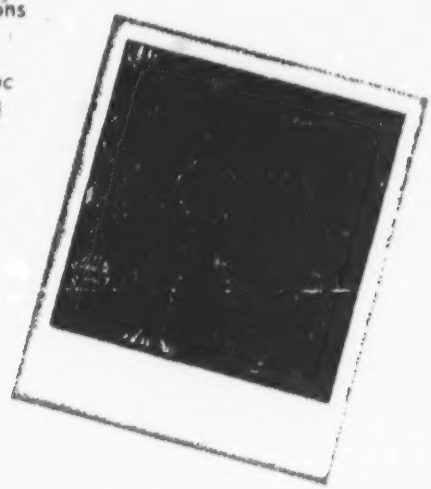
Farndon, John: *Exploring History, Science and Technology.* Lorenz Books (2000), ISBN: 0754804542

Hann, Judith: *How Science Works.* Reader's Digest (1999), ISBN: 0762102497

Kim, Sunnie and Lisa Melton: *Catch a Wave: The Story of Sound and Light.* Science Kids (1999), ISBN: 1891418165

DjiSpezio, Michael: *Awesome Experiments in Light and Sound.* Sterling Publications (2000), ISBN: 0806993111

Clement, Mike: *Light and Sound.* Bbc Pubns (1999), ISBN: 0563375051



Activities and Worksheets

In the Guide

Methods of Science Board 14
Use the flowchart of the scientific method's processes to create a display board to help the students understand the process as the tree house detectives investigate the speed of sound.

Scientific Method Worksheet 15
Match and identify by using the terms of the scientific method.

Colorful Carnations 16
Children use the scientific method to predict, experiment, and draw conclusions about what happens when carnations are placed into colored water.

Mystery Balloons 17
An activity that uses balloons and film canisters to help students understand the difference between an observation and an inference.

Observations and Inferences Worksheet 18
Students practice distinguishing between observations and inferences.

Hot and Cold Water Experiment ... 19
A take-home project to reinforce the student's understanding of the scientific method.

Matrix Board 20
A chart to help students gather and sort data as they view the video.

What Causes Sound? 21
A student worksheet that helps students determine which objects vibrate to create sound.

Word Search 22
A word search highlighting key vocabulary terms.

Vibrations of Sound 23
A teacher handout with numerous activities that are simple and easy to demonstrate or perform by the teacher or the students.

Teacher Answer Key 24
Answer key for all guide and web-based worksheets.

On the Web

You can find the following activities on the Web at http://whyfiles.larc.nasa.gov.

Science Inquiry
An overview of science inquiry that can be used as a teacher resource or a parent handout.

Scientific Method Handout
A brief description of the scientific method.

Scientific Method Check 1
Application of the scientific method for grades 4 and 5.

Scientific Method Check 2
Application of the scientific method for grades 4 and 5.

Color Mixing
Mixing the primary colors by using the scientific method.

Where's That Sound?
Students fine-tune their hearing in pinpointing the location of a sound.

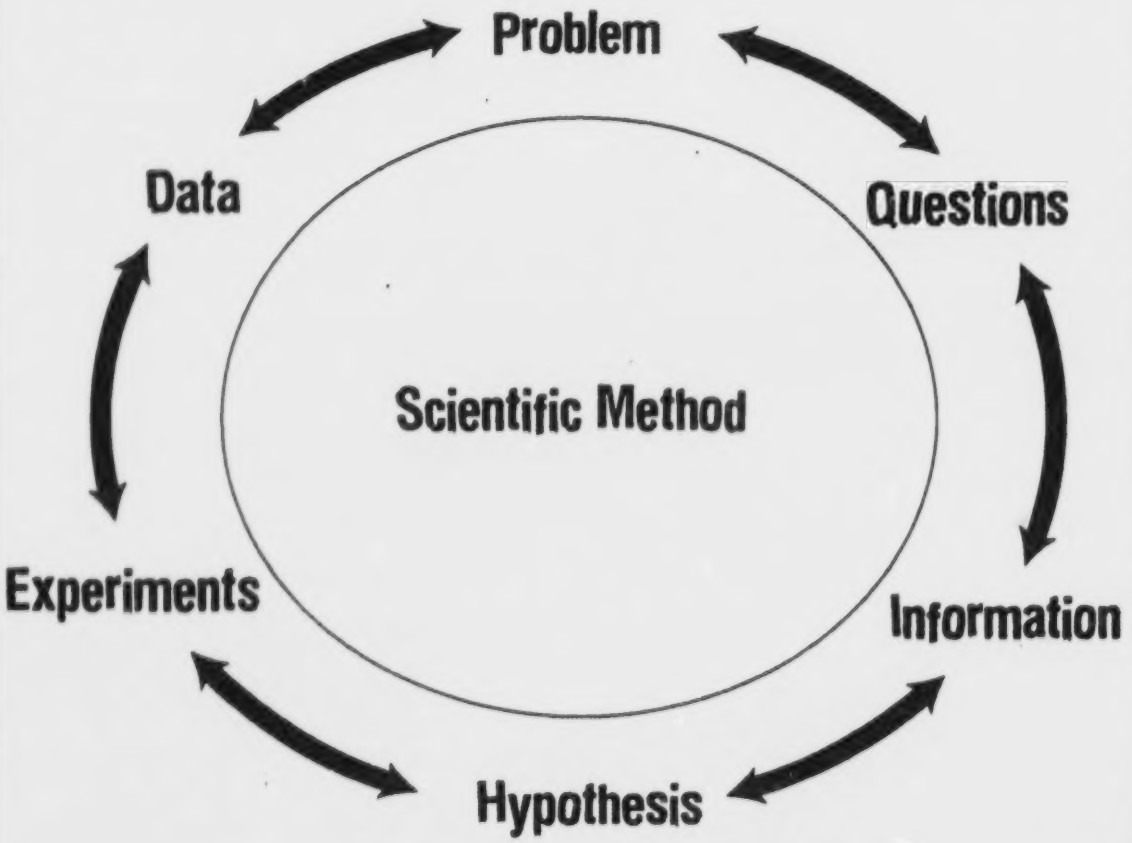
What a Kazoo!
Make a Kazoo and demonstrate the physics of sound and vibration.

Instrument Inventors
Accompanying extension for making a Kazoo. Students will research various musical instruments and their origins.

Methods of Science Board

Create a display board of the following chart and use it to help students understand the processes of the scientific method. Make clear that this is not a step-by-step procedure but rather a flexible process that often changes as information is gathered. For example, if you perform an experiment and your hypothesis is not correct, you may wish to reformulate your problem, do more research, create a new hypothesis, or rewrite your experiment.

To help the students as you view the video, you may wish to write on this chart as the tree house detectives go through the process themselves. Use the board to monitor the tree house detectives' research, hypothesis, and any data they collect. Help the students to see that the tree house detectives often change their hypothesis as the they learn new information.



Scientific Method Worksheet

Match the word with the definition.

A. Problem
B. Research
C. Materials
D. Data
E. Procedure
F. Variable
G. Hypothesis

____1. Looking through books, web sites, or newspapers for information on a topic.

____2. The experiment.

____3. A list of things needed for the experiment.

____4. Always asked as a question.

____5. Observations recorded and put into charts or graphs.

____6. An educated guess as the answer to the problem.

____7. Factor that is changed during an experiment to see what will happen.

8. In the following experiment, which variable is being manipulated (changed)?

Brands A, B, and C of hamburger meat are tested for the amount of fat in each. Each brand will be cooked for exactly 7 minutes. The same pan will be used for each test. The brands will each be drained for exactly 2 minutes by using a strainer and a measuring cup to determine the amount of fat that is drained.

❑ The cooking time

❑ The pan

❑ The brands being tested

❑ The straining of the meat after cooking

Colorful Carnations

Problem How can I add color to white carnations?

Research Suggested topics to research are plants, flowers, stems, color dye, and water movement through a plant.

Hypothesis If I place a carnation into colored water, then the carnation _____ turn that color.
will/will not

Materials

- White carnation for each group
- Observation Chart
- Food coloring
- Clock or timer
- Pencil
- Scissors
- Crayons
- Beaker
- Metric ruler
- Jar
- Water

Procedure

1. Gather all materials needed for the experiment.
2. Measure 200 ml of water and pour into the jar.
3. Add 5 drops of food color to the water and gently shake.
4. Cut the stem of the carnation diagonally so that the carnation measures approximately 20 cm in length.
5. Place the carnation into the jar and observe.
6. Record your observation on the chart. You will need to draw what you see and write a description of your observations; be sure to use all appropriate senses.
7. Make observations every hour until a change is noticed.
8. Share your results with the other groups and draw conclusions.

Data

Observations	Time: 0:00	1 hour	2 hours	3 hours	4 hours
Drawing of Carnation					
Description of Carnation					

Conclusion My hypothesis was _____.
Correct / not correct

Explain why: _____

_____

_____

Going Beyond Explain what you could have done differently in your experiment to make it better.

Extensions How could you extend this activity?

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Mystery Balloons

Purpose

To provide students with experience in making observations and inferences and in determining the difference between them.

Materials

4 black helium balloons per group
materials for filling balloons (flour, sugar, corn, rice)
4 black film canisters with a hole punched in center of each lid per group
objects to put in canisters (rocks, sand, marbles)
toothpick or skewer for each canister (extras may be needed due to breakage)
paper for chart

Procedure

1. Prepare balloons and canisters for students by filling each balloon with a different substance such as flour, sugar, corn meal, or popcorn. Tie off ends. Place different objects in each film canister and secure lid. Place toothpick or skewer in the hole in the center of lid. Students will use these to "feel" the objects.
2. Explain observations and inferences. Observations are made with the five senses. Use as many senses as are appropriate. An inference is like a guess (what you can conclude after your observations).
3. Group students and pass out a set of balloons to each group.
4. Have students observe balloons. Teacher may need to guide students in observations.
5. Have students write their observations on a chart.
6. When students are finished, have them share their observations.
7. Explain that these are all observations.
8. Ask students to guess what is inside each balloon and record guesses on the chart.
9. Have students share their guesses and explain that these are inferences.
10. Tell the students what is inside each balloon.
11. Repeat with the film canisters. Explain that this time you are taking away several of their senses. They no longer have sight and touch is limited by using the toothpick.
12. For a final assessment, you can take a black garbage bag or paper bag and place an item or two in it. Have each student write an observation and an inference.

Extensions

1. Use olfactory jars for sense of smell.
2. Take an object and have blindfolded partner make observations and inferences.
3. Provide a mystery bag for students to practice making observations and inferences.

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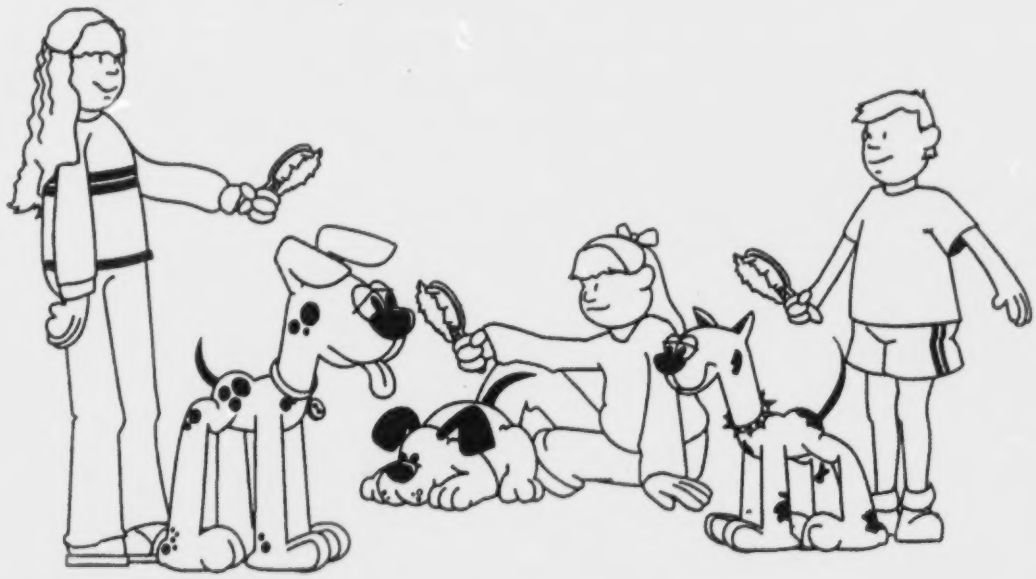
Observations and Inferences

When you perform activities and experiments, you make observations with your five senses; therefore, an observation is something you can see, feel, smell, hear, or taste. There are times when you make judgments or decisions based on logical observations. These judgments or decisions are called inferences. Inferences are logical conclusions based on your observations.

Look at the picture below. Read the statements. Based on what you observe in the cartoon, decide whether each statement is an observation or an inference. Write your choices on the lines.



_____ 1. Three children are holding a brush.

_____ 2. The biggest dog is smiling.

_____ 3. One girl has a bow in her hair.

_____ 4. All the dogs have ears.

_____ 5. The dogs are going to get brushed.

_____ 6. The dogs are all friends.

Make up four inferences or observations of your own (to the right of 7-10). Write the word *observation* or *inference* on the lines to the left to describe each.

_____ 7. _____

_____ 8. _____

_____ 9. _____

_____ 10. _____

Hot and Cold Water Experiment (Take home project.)

Use the following outline to design an experiment to test which will freeze first, hot water or cold water. Be sure to research water and its properties. Factors to keep in mind are how hot is hot, and how cold is cold? You will need to make sure the temperatures are defined. Also, be certain that you have listed all materials you will need for the experiment (as if you are in an empty room). The procedure should be clear and detailed so that anyone can duplicate your experiment with ease. Don't forget your control setup and a list of your variables. Repeated trials are a must! Data should be recorded on a chart. Use the chart information to create a graph for easy display and reading. Finally, be sure to state in the conclusion whether your hypothesis was correct or incorrect. Good luck!

(Title)

Problem Which will freeze first, hot water or cold water?

Research

Hypothesis If I freeze hot and cold water at the same time and in the same size containers, then _____ water will freeze first.

Materials
1. (list form)
2.

Procedure
1. (list form)
2.

Data
Chart
Graph

Conclusion My hypothesis was _____. (Why was it correct or why was it incorrect? Explain.)

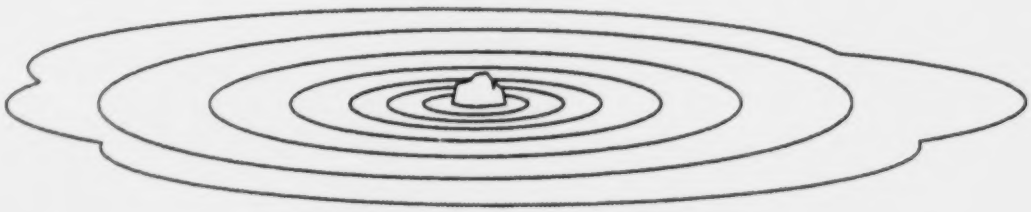
Extension

Going Beyond
What would you do differently next time?
What went right in your experiment?
What went wrong?

Matrix Board

What Causes Sound?

Sound is created by waves. When a stone is thrown into the water, small circles (waves) form and continue to form and spread out beyond the point where the stone entered the water. (See diagram below.) We cannot see sound waves, but we can hear them. Vibration causes sound waves. The vibrating object moves the air, and this movement creates the sound we hear.



Ripples on the water from a stone are like waves created from vibrations in air.

Use your knowledge of objects and vibration to determine what type of object is vibrating to make the following sounds.

_____1. A dog barking

_____2. A piano playing

_____3. A person speaking

_____4. A clarinet playing notes

_____5. A bell ringing

Think of other sounds and tell what is vibrating to make the sound.

6._____

_____

_____

_____

_____

_____

Word Search

M W B G F T K M J H Y O P L U A T A D
E E G R F D V B J H Y J U J U J V I U
T H Y P O T H E S I S Y W Q M K I P R
H V C D E L S O G O T K E A M U B D E
O C U Y T R E V A R I A B L E S R R S
D T S K A B H P Q L I N R X L O A R E
S U Y U U I Y O I L K U A R W D T K A
O B V O L I C N B I N C T K E A I S R
F X H U Y R N K H S J U Y H G B O Y C
S R T W H F E V T G E B V C U I N P H
C J S P O S U E K F I R V I U X S D K
I M I B V U Q L P S G E V Y A S H N V
E S T U R H E E H U Y H Y A K G F H I
N D N N B V R R T Y U O L K T G F D X
C F E H K G F L K J H F L A K I J D L
E O I N M N V F O I U Y E A P H O Q K
H N C E D B C N K Z D F C X K I L N T
R T S C I E N T I F I C M E T H O D G
V C X S K P O Z W Q D J H G M K I K H
D L K M N C U K Y T J R E W Q G H J Q
F R T Y D S C O N C L U S I O N Y G Y

- conclusion
- data
- frequency
- hypothesis
- methods of science
- observation
- research
- scientific method
- scientist
- variables
- vibrations

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Vibrations of Sound Activities and Demonstrations

These activities can be used by the teacher or at home to help teach and reinforce the concepts and objectives of this segment. These activities can be explored and used to encourage learning through investigation.

1. Hold one end of a rubber band between your teeth. Pull the other end a little but not enough to break it. Pluck it. What vibrates?

2. Strike a tuning fork. Dip its prongs into a glass of water. What do you observe?

3. Suspend a cork on a string so it can move freely. Strike the tuning fork and hold the prongs against the cork. What happens?

4. Tie several pieces of silverware close together on a string. Hold the two ends of the string to your ears. Have someone tap the utensils so they bump together. What do you hear?

5. Place several grains of rice or seeds on the surface of a can or box. Strike the container with a ruler. What do you observe? Try different size cans or boxes. Do the sounds vary? Do the seeds behave differently?

6. Inflate a balloon. Hold it lightly near your lips as you speak. Speak loudly. Speak more softly. What did you notice?

7. Set an alarm clock. Let it ring while it is sitting on a solid surface such as a desk. Describe the sound. Let it ring again while it is sitting on a rug or other soft surface. How did the sound change? Why did it change?

8. Strike a tuning fork and gently touch its prongs against the side of a glass. What happens?

9. Strike a tuning fork. Hold it near your ear. Touch the tuning fork. What did you feel? What did you hear?

10. Strike a tuning fork. Place the tip of the fork in a small bowl of water. What happened to the water? Why did this occur?

Teacher Answer Key

Scientific Method Worksheet

1. B
2. E
3. C
4. A
5. D
6. G
7. F
8. the brand being tested

Observation and Inferences

1. Observation
2. Inference
3. Observation
4. Observation
5. Inference
6. Inference

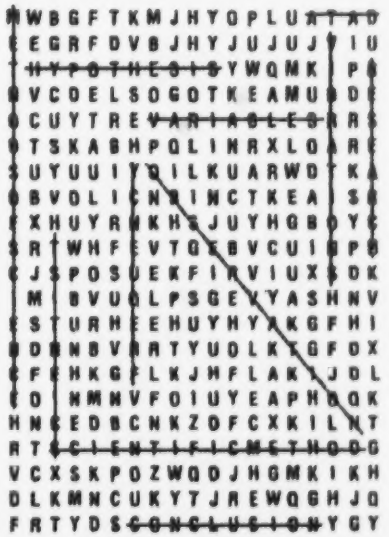
7-10 Answers will vary

What Causes Sound?

vocal chords
strings
vocal chords
wooden reed on clarinet
metal that surrounds the bell

6-10 Answers will vary

Word Find



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The NASA "Why?" Files
The Case of the Barking Dogs

Segment 2

The tree house detectives continue their investigation into what is causing the dogs to bark. They decide to use the neighborhood map to analyze and record responses from the neighbors. The next step in their investigation is to brainstorm about what sounds make dogs bark and then visit an audiologist to learn more about human ears. Next, they visit a NASA psychoacoustician to find out about the psychological effects of noise on human beings (noise pollution). The children wonder whether noise pollution from high-frequency sounds is causing the dogs to bark. The Methods of Science play a role in keeping the kids focused on the problem, and they decide to do more research by visiting their local veterinarian to see if they are still on target with the original hypothesis. The doctor explains the difference between human hearing and dog hearing and guides the children into considering high-frequency noises as a possible cause of the dogs' barking. The detectives visit the anechoic chamber at NASA to learn more about how sound travels. With the help of Dr. D., the children learn about frequency and how it affects wavelength. The children think they have narrowed down the probable cause of the barking dogs...but have they really?

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Objectives

The students will

- learn map skills by using a local map.
- learn to use pictograph representations with pushpins of various colors.
- learn about noise pollution and how noise frequency affects humans and animals.
- determine the range of frequencies for human hearing by learning more about the human ear.
- determine the range of frequencies for dog hearing by learning more about the dog ear.
- discover similarities and differences between the dog ear and the human ear by using a Venn Diagram.
- discover how sound becomes softer as it travels away from the source.
- discern different sounds by a sound egg activity.
- learn how frequency affects wavelength with the use of pan pipes and squawkers.
- learn, through research, how animals are adapted for hearing.
- measure length using the metric system.

Vocabulary

absorb - to take in and not reflect

anechoic chamber - a special chamber that absorbs sound

audiologist - a person who helps others with hearing difficulties

consumer - a person who uses goods for his own needs

echo - the repetition of a sound by reflection of the sound waves from a surface

high frequency - a greater number of sound waves passing a particular point in one second. Frequency is measured in Hertz (abbreviated Hz)

matrix - a set of numbers or terms arranged in rows and columns used to sort and organize data for interpretation

pattern - an arrangement of shapes or colors in an order

pest zapper - an electronic device that emits high-frequency sounds at a frequency level that deters insects from a given area

pollution - the contamination of the soil, water, or air with substances that don't belong

psychoacoustician - a person who investigates the psychological effects of noise on human beings

resonance - a condition in which the frequency of an external force matches with the natural frequency of an object

sonic - having to do with the speed of sound (738 mph at sea level)

veterinarian - an animal doctor

Video Component (15 min)

Before Viewing

1. Briefly summarize the events in segment I with the students.
2. Ask the students to hypothesize the cause of the barking dogs.
3. Review the Methods of Science. You may wish to choose an activity from segment I that you have not performed and use it as a review for the scientific method.
4. Introduce the vocabulary. Have students write a definition for audiologist, psychoacoustician, and veterinarian and share their responses.
5. Ask the students to predict what will happen in segment 2.

View the Video

View segment 2 of the video. Discuss the questions that are asked at the end of the second segment.
- Will the tree house detectives solve the case?
- Do you think their hypothesis is right or wrong?
- Are high- and low-frequency important in solving this problem?

After Viewing the Video

1. Continue to guide students in modifying and adding to the Methods of Science Board created in segment I, (p.14).
2. Choose from the activities in this packet (p. 30-37) to help reinforce the concepts and objectives being emphasized in segment 2.

Careers

Audiologist
Psychoacoustician
Veterinarian
Animal Trainer
Ears, Nose, and Throat Doctor (ENT)

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Resources

Web Sites

Noise & Noise Control

Explores how to measure noise and explains what levels of noise pollution are dangerous. http://www.tir.com/~ms/noisecontrol/noisecontrol.html

The Noise Center has links for noise facts, hearing hazards, airport noise, journal articles, and a children's section.
http://www.lhh.org/noise/index.htm

Diagram of Human Ear

http://www.audiologyawareness.com/hhelp/anat100.gif

Hearing Information

How we hear, hearing tests, types of hearing loss and hearing loss to newborns and infants are some of the topics explored.
http://www.audiologyawareness.com/hhelp/lib.htm

Exploration of Sound

The Soundry site teaches you about the ear, the physics of sound, and the how sound is used in today's world. http://library.thinkquest.org/19537

Books and References:

Martin, Michael C. and Summers, Ian R., Editors: *Dictionary of Hearing.* Whurr Pub Ltd, September 1999, ISBN 1861561326

Charles, Veronika Martenova: *Hey, What's That Sound?* Stoddart Kids, December 1996, ISBN 0773757023

Gibson, Gary: *Hearing Sounds (Science for Fun).* Copper Beech Books, September 1995, ISBN 156294323

Baker, Alan: *I Thought I Heard (Noises).* Copper Beech Books, April 1996, ISBN 0761304606

Van Cleave, Janice: *Physics for Every Kid.* John Wiley & Sons, March 1991, ISBN 0471525057

Pfeffer, Wendy: *Sound All Around.* HarperCollins Juvenile Books, January 1999, ISBN 0060277114

Activities and Worksheets

In the Guide

Neighborhood Pictograph Activity . . .30
A cooperative group activity in which students create a neighborhood map and make a pictograph.

Diagram of Human Ear 32
A worksheet that diagrams the human ear.

Diagram of Dog Ear 33
A handout that shows a diagram of a dog ear.

Venn Diagram 34
A worksheet to use for comparing and contrasting the human ear with the dog ear.

"Sounds Like" Activity 35
Students have the opportunity to "tune-up" their hearing by guessing what is creating the sound produced in a plastic egg.

Metric Hunt 36
A scavenger hunt helps reinforce the metric system for measurement of length.

Inverse Relationships 37
A worksheet to help students understand inverse relationships.

Teacher Answer Key 38

On the Web

You can find the following activities on the Web at http://whyfiles.larc.nasa.gov.

Play Those Pipes Again Sam
Make your own pan pipes to give students an experience with varying frequencies.

Squawker
Give students the opportunity to explore pitch by varying the length of a straw.

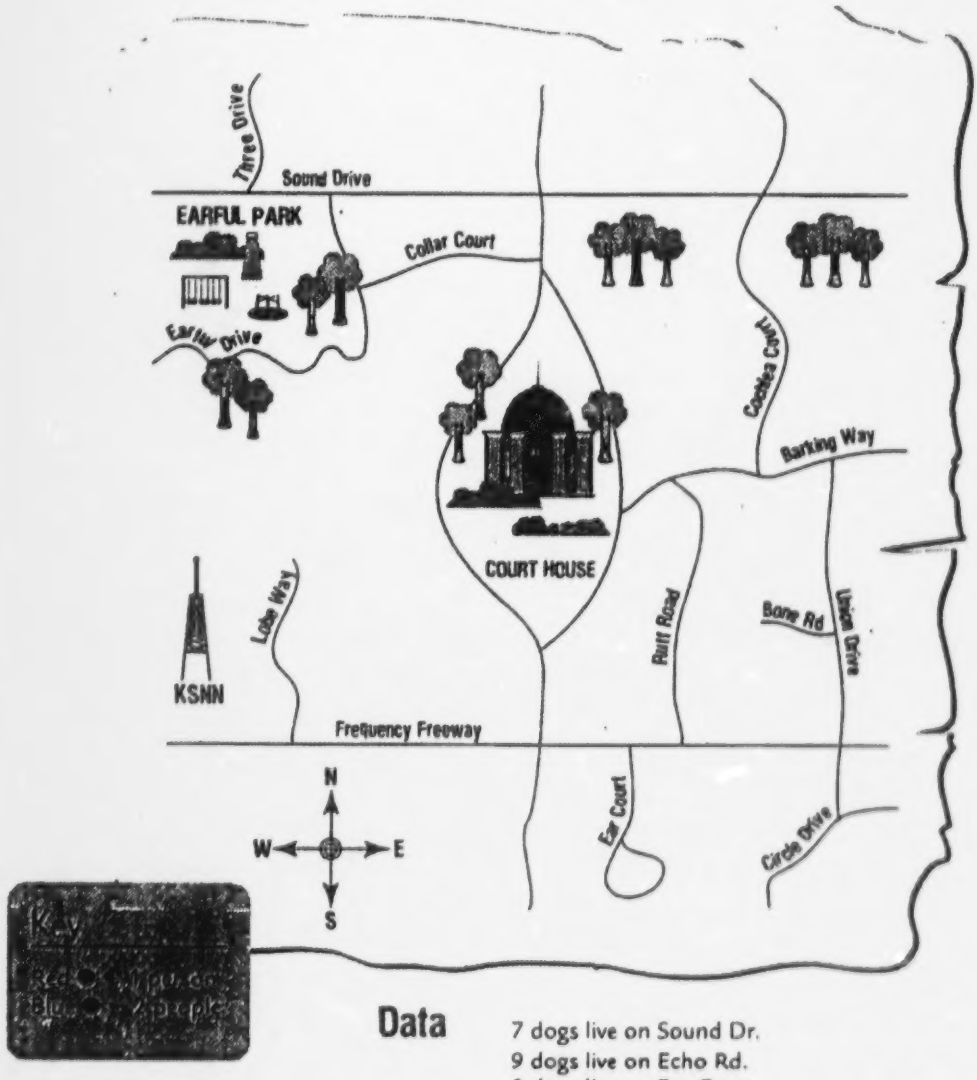
Animal Adaptation for Hearing
A handout and research guide for students to explore how animals' hearing adapts to their environment.

Neighborhood Pictograph Activity

Purpose To give students an opportunity to explore maps and pictographs.

Use color coding to represent the number of dogs on each street. Draw the appropriate number and color of dots on each street. For example: 3 dogs will equal one red dot and one blue dot.

Map of Echo Holler



Data

7 dogs live on Sound Dr.
9 dogs live on Echo Rd.
8 dogs live on Ear Court
13 dogs live on Frequency Freeway
5 dogs live on Cochlea Court

30

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Neighborhood Pictograph Activity

Create a pictograph. Choose a symbol to represent 10 people who heard loud sounds and draw the appropriate number and type of symbol in the space provided:

	# of People who Heard Loud Sounds	Pictograph
Noisy Nook	25	
Seaside Sound	50	
Hollow Sound	77	
Echo Holler	105	
Auditory Lane	57	
Impulse Road	35	
Canal Street	48	
Reverberation Row	90	

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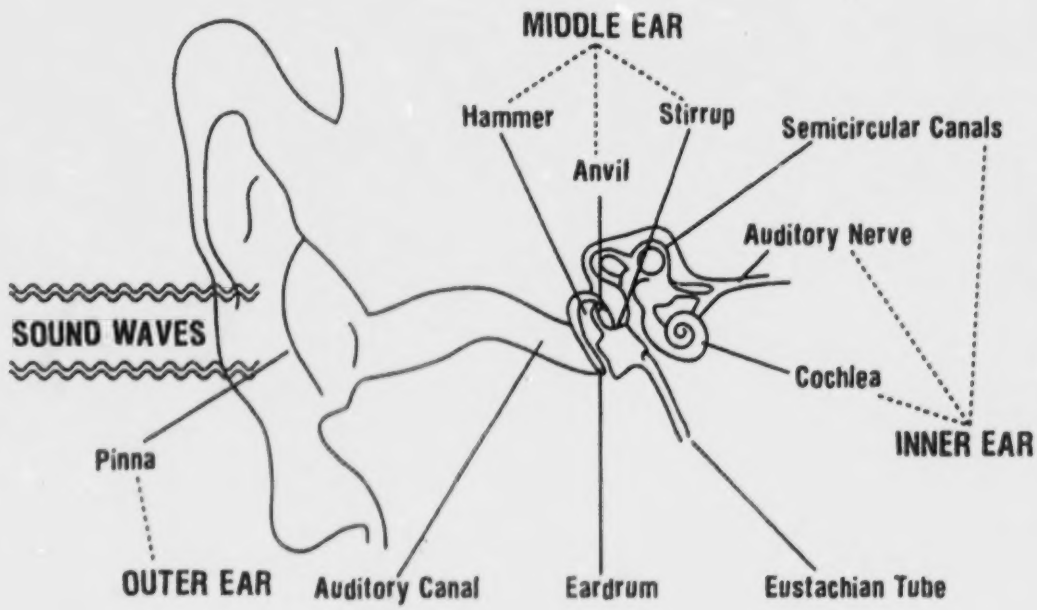
Diagram of Human Ear

The outer ear collects and concentrates sound energy, which is then channeled down the ear canal. The eardrum vibrates, along with the small bones within the ear. The sound then goes through the cochlea, the hair cells bend, and the impulses are sent up the auditory nerve to the brain where they are decoded.



Label the following parts of the ear:

_____ 1. Connects ears with the throat.

_____ 2. Snail shaped part of the inner ear.

_____ 3. Part of the ear on the outside of the head.

_____ 4. First part of the ear to vibrate.

_____ 5. Middle bone of the ear.

The higher the sound, the more rapidly your eardrum vibrates. The lower the sound, the slower your eardrum vibrates. Give two examples of sounds that will make your eardrum vibrate very quickly and two examples of sounds that will make it vibrate more slowly.

Sounds that make your eardrum vibrate very quickly:

6. _____

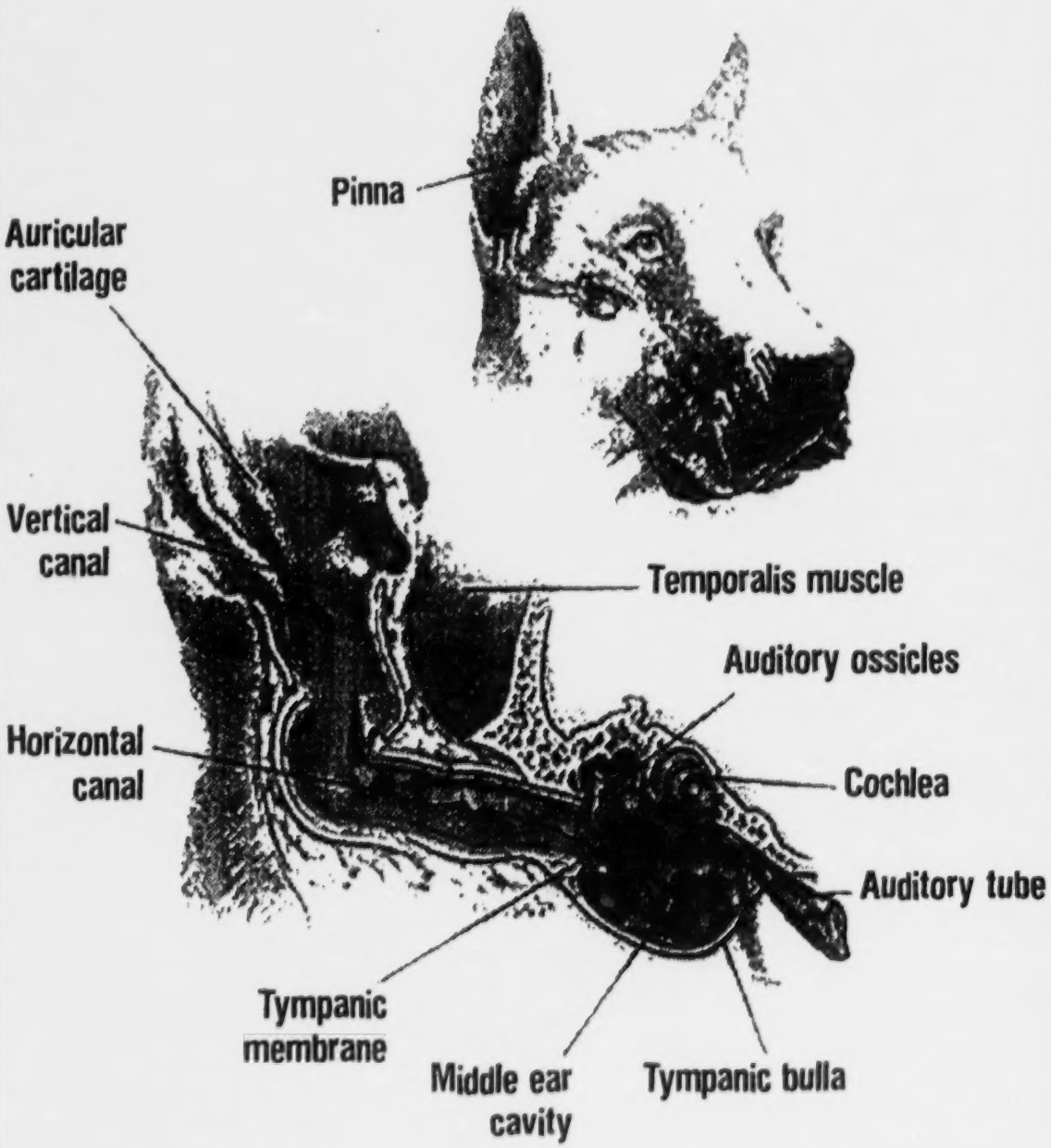
7. _____

Sounds that make your eardrum vibrate more slowly:

8. _____

9. _____

Diagram of Dog Ear



33

Venn Diagram

"Sounds Like" Activity

Purpose To give students the opportunity to "tune-up" their hearing by guessing what is creating the sound produced in a plastic egg.

Materials

- **5 plastic eggs** numbered 1-5 for each set of partners
- **Small items** such as rice, beans, paper clips, eraser tops, marbles, etc. Enough of each to fill the maximum number of eggs needed.
- **Paper/Chart**
- **Pencil**

Procedure

1. Have one person of each pair select 5 eggs, mark each egg with the numbers 1-5, and fill each egg with a different set of objects. (The teacher may do the numbering before beginning the activity.)
2. Fill each egg with a different set of objects.
3. The student's partner will shake each egg, one at a time, and listen carefully to the sound to guess what is in the egg.
4. Record guess on the "Sounds Like" Chart below.
5. Once all eggs have been shaken and guesses have been made, the students can open their eggs and compare their guesses with the correct answers.
6. Switch positions and repeat with other partner.

SOUNDS LIKE CHART

Egg #	Partner 1		Partner 2	
	Guess	Actual	Guess	Actual
1				
2				
3				
4				
5				

Conclusion

1. How did the weight of the objects affect the sound of the object?
2. Which objects were high-frequency sounds? Low-frequency sounds?
3. Which object was the loudest of all? Why?

Extension Teacher can create a set of eggs for each group with identical objects in each. Students work in groups to discern what objects are in the eggs. The group with the most correct answers wins "Great Ears" for the day! Chart or graph class responses.

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Metric Hunt

Purpose To give the students an opportunity to estimate and measure length using the metric system.

Try to Find Objects of These Lengths

Lengths	Name of Object	Actual Measurement	Difference
1 m			
24 cm			
5 cm			
3 m			
2 1/2 m			
16 cm			
25 mm			
8 cm			
94 cm			
2 m			

37

Inverse Relationships

The term "inverse relationship" is used to describe a relationship between two things, wherein one of them increases while the other decreases.

Example: The more I lick my ice cream cone, the less ice cream I have.

I. Read each of the following to determine whether it could be labeled an inverse relationship. Place a check beside the ones you choose.

_____1. Students laid a paper "bridge" across two blocks of wood and placed some pennies on it to see how much it would hold before it collapsed. When they made the bridge longer, they discovered that the longer the bridge, the fewer pennies it would hold.

_____2. Beth and Allen are sitting on a seesaw (teeter-totter). Allen notices that the farther he moves from the center of the seesaw, the longer Beth stays elevated.

_____3. A bus driver coming home from a long trip noticed that when he increased his speed, the time it took for the trip shortened.

_____4. Charlie has a savings account that earns interest every year. He noticed that the longer he leaves his money in the account, the more money he has.

_____5. Becky bakes cookies and sells them. She has been raising the price of the cookies each week, and each week she has been selling fewer cookies.

II. Consider each graph. Which graph(s) describe an inverse relationship?_____

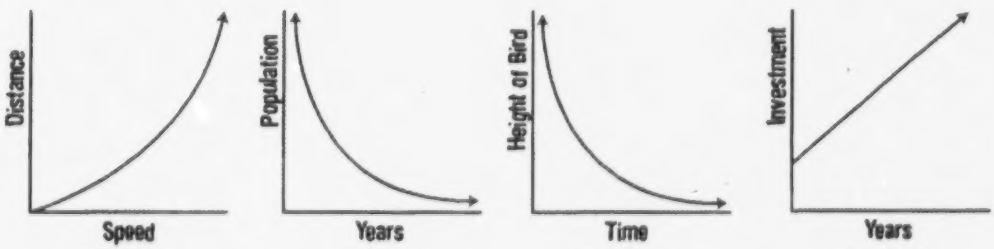

Chart A Chart B Chart C Chart E

Teacher Answer Key

Diagram of Human Ear
1. eustachian tube
2. cochlea
3. pinna
4. eardrum
5. anvil
6-9 Answers will vary.

Inverse Relationships
I. 1, 3, 5
II. B, C

The NASA "Why?" Files
The Case of the Barking Dogs

Segment 3

The investigative team continues to search for the cause of the barking dogs. Those pesky dogs are keeping the neighborhoods awake at night, causing the residents to go without their beauty sleep! The tree house detectives examine the matrix to eliminate possible causes and narrow their focus. Using the Methods of Science, they decide to perform an experiment in the classroom to find out how fast sound travels. After repeated trials, they analyze their data and are quite impressed with how fast sound really does travel! Next, they are off to visit Dr. D., a retired science professor, to find out more about how sound travels through different mediums. A NASA scientist, who specializes in acoustics, explains how mediums absorb sound and shares information about sonic booms and high frequencies. Does frequency have something to do with the dogs' barking? The tree house detectives think they are getting closer to solving this mystery.

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Objectives

The students will be able to

- measure the speed of sound by creating echoes and using and manipulating the distance formula (S=D/T).
- measure length using the metric system.
- convert decimals to common fractions (1/4, 1/2, 3/4, 1/3, 2/3) by making a correlation between pictures and their corresponding fractions.
- state the properties of the three states of matter (solid, liquid, and gas) through investigation.
- discover the effect that different mediums have on sound through discovery activities.
- write a business letter by writing to various professionals to learn more about sonic booms.
- write a persuasive paper taking a stand on a controversial subject.
- learn more about possible career choices through research and investigation.

Vocabulary

analyze - to examine in detail

average - the result of dividing the sum of two or more quantities by the number of quantities

bounce - to spring back

calculate - to determine by using mathematics

disturb - to interrupt

echo - a reflected sound

elasticity - the ability to return to its original shape or state

eliminate - to get rid of or to remove

high pressure - a high concentration of densely packed air molecules

low pressure - decrease in the concentration of air molecules

medium - states of matter: solid, liquid, or gas

meters - a metric measurement equal to a little more than a yard (3 feet)

rhythm - regular recurrence of a beat

sonic boom - a shock wave caused by something traveling faster than the speed of sound, such as a plane or a clap of thunder

shock wave - an extremely fast movement of air that produces a sonic boom

temperature - the degree of hotness or coldness of anything

tension - stress on a material produced by the pull of forces that causes extension

trials - the process of trying or testing

Video Component (15 min)

Before Viewing

1. Help students summarize briefly what took place in segment 2.
2. Review the scientific method.
3. Ask students how fast they think sound travels in a second.
4. Assess students' knowledge of sonic booms. Brainstorm for ideas about what causes sonic booms and why we hear them.
5. Have students sort and classify vocabulary words for segment 3 into categories according to common characteristics. Share, as a class, the different groupings that have been generated. Using this knowledge, predict what will happen in segment 3.

After Viewing the Video

1. Discuss these questions that are asked at the end of video segment 3.
   - Do you think dog whistles are the source of the problem?
   - Are the dogs hearing a sound from inside their houses or could there be another reason for the barking dogs?
2. Make a display of the Methods of Science Board (p. 14). Refer to the chart as the students go through the scientific method to reinforce that it is not a step-by-step process, but rather an interdependent relationship.
3. Choose from the activities in this packet (p. 43-49) to help reinforce the concepts and objectives being emphasized in this segment.

Careers

Mathematician
Airplane Pilot
Airplane Mechanic
Naval Aviators
Air Traffic Controllers
Research Engineers
Computer Scientist

Resources

Web Sites

Sonic Boom
A NASA site that explains how sonic booms are created.
http://www.dfrc.nasa.gov/PAO/PAIS/HTML/FS-016-DFRC.html

Book Resources

Taylor, Richard: *The First Supersonic Flight: Captain Charles E. Yeager Breaks the Sound Barrier.* Franklin Watts, Inc., October 1997, ISBN 0531201775

Smith, Elizabeth Simpson: *Coming Out Right: The Story of Jacueline Cochran, the First Woman Aviator to Break the Sound Barrier.* Walker and Company, March 1991, ISBN 0802769896

Stein, Conrad R.: *Chuck Yeager Breaks the Sound Barrier.* Children's Press September 1997, ISBN 0516261371

Osborne, Louise and Hodge, Deborah, the Ontario Science Centre, and Mason: *Solids, Liquids, and Gases (Starting with Science).* Kids Can Pr, March 2000, ISBN 1550744011

VanCleave, Janice: *Janice VanCleave's Molecules.* John Wiley & Sons, September 1992, ISBN 0471550541

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Activities and Worksheets

In the Guide

Zoom! The Speed of Sound 43
An activity where the students investigate the speed of sound.

"Ruff" Average 45
A worksheet that gives students the opportunity to solve problems by using averaging.

Fractional Relationships 46
A worksheet to help students understand the relationship between fractions and decimals.

Matter 47
Informational sheet which provides an opportunity for the students to identify three states of matter.

Moving Molecules 48
An experiment that students can perform to discover that molecules are always moving.

Teacher Answer Key 49

On the Web

You can find the following activities on the Web at http://whyfiles.larc.nasa.gov.

Molecules and Matter
An informational worksheet for three states of matter.

Green Slime (Ooblik)
An experiment to reinforce observations and inferences of solids and liquids.

Take a Stand
An activity for writing a persuasive paper and/or a a business letter.

Zoom! The Speed of Sound

Purpose To investigate the speed of sound.

Problem How can the speed of sound be measured?

Materials (per group)

- 1-3 meter sticks per group
- 2 metal pipes approximately 1 inch in diameter and 5 inches in length.
- Paper and pencil (data chart)
- Stopwatch or watch with a second hand
- Goggles for each student
- A large, open area with a building that will create an echo

Procedure The first portion of this experiment will be conducted in a large, open area with a building that will create an echo.

1. Divide the students into groups of three.
2. Assign jobs: timekeeper, echo maker, and data recorder
3. Gather materials and go to a large, open area.
4. Use meters sticks to measure, in as straight a line as possible, a distance of 57 meters from one wall of the building to an open area. (This area should be free of other buildings that would be close enough to interfere with the reverberation of sound.)
5. Mark the distance by laying the meter sticks across the ground at the 57-meter point.
6. Wear safety goggles.
7. Have the echo maker begin to clap pipes together and to listen for the echo.
8. Once the echo has been identified, try to establish a rhythm, with the echo coming in between the claps of the pipe.
9. When ready, the echo maker will signal to the timekeeper to begin timing and counting claps for 20 seconds.
10. Timekeeper will announce that 20 seconds has elapsed, and the echo maker will tell the recorder how many claps he counted.
11. Recorder will record the number of claps in the data chart.
12. Repeat steps 7-11 for at least three more trials.
13. Return to classroom.
14. Using the data, find the average for the number of claps. (To average, add all the numbers and divide by how many numbers you added.)
15. To find the time between claps, divide the number of claps by time and round your answer to the nearest hundredth. This decimal represents the time between claps.
    Example: If you had 0.666, round it to 0.67.
16. Since the echo occurred between the claps, the time that it took for the sound to travel to the wall and back is 1/2 the time between claps.
    Example: 0.67 ÷ 2 = 0.335 = 0.34
17. The distance the sound traveled was 114 meters (57 meters to the wall and 57 meters from the wall).
18. To calculate the speed of sound, divide distance traveled by time.
    S = d/t
    S = 114 ÷0.34
    S = 335.29 m/sec
19. Compare group answers. Find the speed of sound in a reference book and compare your answers to the correct answer.

Conclusion

1. What affected the differences in the answers from the various groups?
2. How could you have achieved a greater accuracy?
3. What factors could "slow" sound down?
4. What would happen if we went faster than the speed of sound?

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Zoom! The Speed of Sound

Data Chart

Trial # (30 seconds)	# of Claps
1	
2	
3	
4	
5	

To find an average, add the number of claps for all 5 trials and divide by 5.

Step 1: _____ (Trial 1) + _____ (Trial 2) + _____ (Trial 3) + _____ (Trial 4) + _____ (Trial 5) = _____ (Sum of all Trials)

Step 2: _____ (Sum of all Trials) ÷ 5 = _____ (Average)

Step 3: _____ (# of claps) ÷ _____ (Time) = _____ (Time between claps)

Step 4: _____ (Time between claps) ÷ 2 = _____ (Time sound traveled)

Step 5: 114m (Distance) ÷ _____ (Time) = _____ (Speed of Sound)

"Ruff" Average

Finding the average is fun! It is also useful to help you calculate your grade in science throughout the year. Here's what you do:

Add all the given numbers in a set of numbers to find the total.

Example: 10 + 4 + 5 + 15 + 2 + 6 = 42

Now, divide your answer (42) by how many numbers you added together. In this example, you added 6 numbers together; therefore, you divide 42 by 6.

Example: 42 ÷ 6 = 7

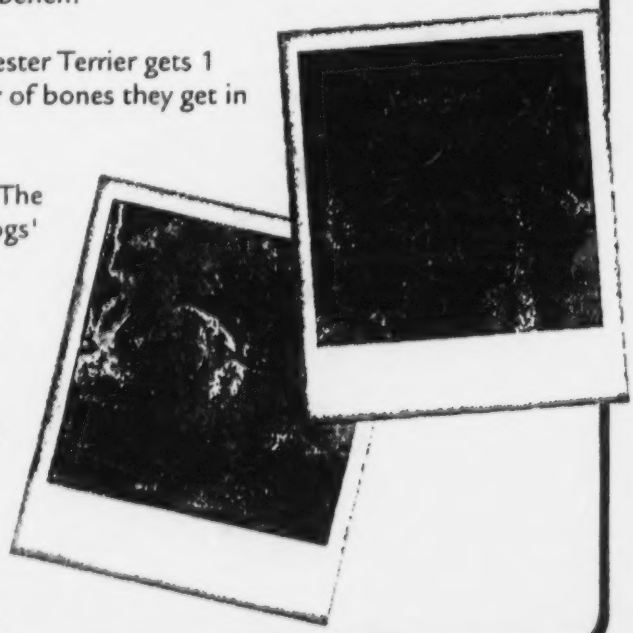
Find the average in each word problem below.

1. A Siberian Husky eats 15 pounds of food a month. A Labrador Retriever eats 23 pounds of food a month. What is the average amount of food these two dogs eat in a month?

2. It was a dog's day afternoon at the neighborhood park. It was too hot to play fetch and too hot to chase the neighbor's cats. The pooches were panting from the heat. What a gathering of dogs! There were 9 German Shepherds, 5 Airedales, 7 Collies, and 3 Greyhounds. If there were only 4 benches in the shade for the pooches to share, what is the average number of dogs per bench?

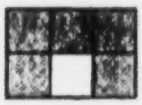
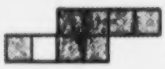
3. A Bulldog gets 3 bones a day. A Manchester Terrier gets 1 bone a day. What is the average number of bones they get in a week?

4. The local veterinarian held "weigh day." The dogs lined up around the corner. The dogs' owners were eager to see if the new dog food was getting their hounds in shape. The weights of the first six dogs were 26 pounds, 15 pounds, 28 pounds, 29 pounds, 33 pounds, and 37 pounds. What was the average weight of the first six dogs?



Fractional Relationships

I. Write the fraction that describes the shaded portion of each figure below.

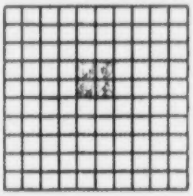
_____ _____ _____ _____ _____ _____

II. Determine if the fraction is less than or greater than 1/2. If the fraction is greater than 1/2, write it to the right of 1/2. If the fraction is less than 1/2, write it to the left of 1/2.

Example: 1/3 ___1/3___ 1/2 _____

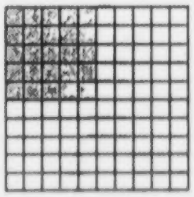
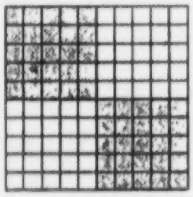
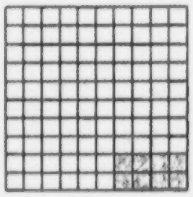
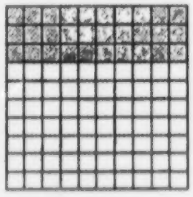
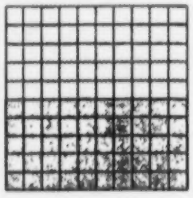
1. 1/4 _____ 1/2 _____
2. 5/8 _____ 1/2 _____
3. 1/6 _____ 1/2 _____
4. 4/5 _____ 1/2 _____
5. 2/3 _____ 1/2 _____

III. Write the fraction (in simplest form) and the decimal that describes the shaded region of each figure. Use your knowledge of writing equivalent fractions to check your answers.



Example: $\frac{4}{100} \frac{\text{(divided by 4)}}{\text{(divided by 4)}} = \frac{1}{25}$

1/25 = .04

____ - ____ ____ - ____ ____ - ____ ____ - ____ ____ - ____

Matter

Look around the classroom and list ten things that you see. All these things are matter. Matter is anything that has mass (weight) and takes up space. Three forms (states) of matter are solid, liquid, and gas. Your pencil, desk, and paper are examples of solid matter. Water, milk, and juice are examples of liquid matter. Gases are things such as the air you breathe, the air you exhale, and the helium that fills balloons.

Some matter can be found in more than one state. Water is a good example. Under normal conditions, water is a liquid. However, when the temperature drops below 0° C, it changes to a solid state in the form of ice. When the temperature of water is increased to 100° C or higher, it will begin to boil and produce steam. Steam is water in the gaseous form. Water vapor in the air is also a gas which we call humidity.

Some metals, such as iron, are solid until they are put under very high temperatures. Then they become a liquid or molten. Lava is in a molten state, but as it cools it becomes a solid. Mercury is a metal that is in liquid form in its natural state.

Carbon dioxide is a gas in its normal state, but in very low temperatures it will change into a solid form. We call this form dry ice. It is called dry ice because it does not melt like ordinary ice. Instead, it goes directly from a solid to a gas. Dry ice makes a smoky appearance as it melts.

Review Exercises

1. List five objects that are solid.

2. List five objects that are liquid.

3. List five gases.

4. What makes a solid turn into a liquid?

5. What makes a liquid turn into a solid?

6. Define "molten."

7. List as many metals as you can.

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Moving Molecules

Purpose To investigate that molecules are always moving.

Procedure
1. Fill the beaker or jar 2/3 full with water.
2. Place beaker or jar in an area where it can be observed without being disturbed.
3. Let the water "settle" for a few minutes.
4. Add 4-5 drops of food coloring to the water.
5. Observe what happens to the food coloring.
6. Record your observations at the time intervals listed in this chart.
7. Clean and restore materials.

Time	Observations	Picture of Observations
0 min		
30 sec		
1 min		
1 min & 30 sec		
2 min		
3 min		

Conclusion
1. Are molecules always moving?
2. Explain what happened to the food coloring and why.

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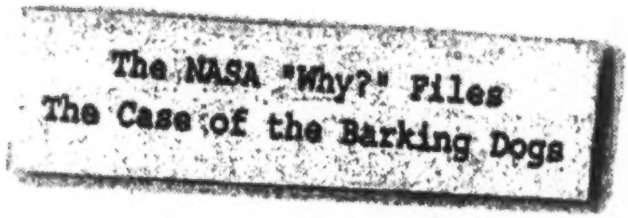
Teacher Answer Key

Fraction Relationships

I. 1. 1/2
2. 3/4
3. 2/5
4. 5/6
5. 7/8
6. 1/10

II. 1. Left side
2. Right side
3. Left Side
4. Left side
5. Right side
6. Right side

III. 1. 1/4 = 0.25
2. 1/2 = 0.50 or 0.5
3. 2/25 = 0.08
4. 3/10 = 0.03
5. 47/100 = 0.47



Segment 4

The tree house detectives are getting very close to solving the case of the barking dogs. They use deductive reasoning to figure out what is not causing the dogs to bark. They also review what they have learned about high-frequency sounds and how sound travels through different mediums. They decide to do an internet search on the different kinds of things that make high-frequency sounds. The search leads them to a bat curator at a local museum who helps them discover an animal who uses high-frequency sounds. They learn about echolocation and its usefulness to bats. The children think there might be a correlation to the dogs' barking and electronic devices being used by the neighbors. They e-mail the neighbors who responded to their first e-mail to see if there is a connection. In the meantime, Dr. D suggests that he present a "show and tell" to their class on how low- and high-frequency sounds travel. After returning to the tree house, the detectives are really surprised at the many responses to their e-mails! The children use the matrix to sort through the e-mails and analyze their data. They were right! There is a connection. KSNN reports that Mr. Big T (the traveling Gum Sonic Toothbrush salesman) has been selling faulty electronic toothbrushes. The children have finally put it all together! Case solved. One visit to Dr. D's lab, a quick demonstration of the faulty electronic toothbrush, and Bernie the dog's reaction, prove the toothbrushes were producing a frequency that caused dogs to bark. They further deduce that the dogs that were barking inside the house were causing the dogs outside to bark. The tree house detectives review how they used the scientific method to solve the case of the barking dogs.

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Objectives

The students will be able to

- learn how a bat uses high-frequency sound.
- learn more about electronic devises that make high-frequency sound.
- discover how high- and low-frequency sound waves travel.
- use a matrix to analyze and sort data.

Vocabulary

devices - a mechanical contrivance

echolocation - the system of acoustic detection that allows bats and other mammals to orient themselves by emitting ultrasounds that bounce off other objects

electric dog repeller - an electronic device that makes a high-frequency sound that makes dogs leave a desired area

eliminate - to leave out of consideration, omit

internet search - using the Internet to find information

navigate - to steer or direct

possibilities - things that may or may not happen

respond - to react

Video Component (15 min)

Before Viewing

1. Summarize briefly what took place in segment 3.
2. Review the scientific method.
3. Introduce the concept of "surfing the web" (internet searches).
4. Using the worksheet provided, have the students conduct a Web Search Scavenger Hunt (computer with internet capabilities required).
5. Have students brainstorm a list of possible items that could make high-frequency sounds. This could be a web search activity.
6. Based on previous segments and knowledge of sound, have students predict what they think is causing the dogs to bark.

After Viewing the Video

1. Continue to guide students in modifying and adding to the Methods of Science Board created in segment 1 (p. 14).
2. Discuss the students' reactions to the solution of the problem and the predictions they made previously.

Resources

Web Sites

Uses for Sound Waves

A web site that explores how sonar helps paleontologists look for dinosaurs in New Mexico. http://www.oml.gov/ornl94/blasting.html

Tulane orthopedists are using low-intensity sonic ultrasound waves to get patients with fractured bones out of plaster faster.
http://www.som.tulane.edu/TMCinfo/monitor/nov95.Casting.html

Sonic Boom

A primer describing how a sonic boom is created, including 3D images.
http://www.galcit.caltech.edu/~brad/boom/boomprimer.html

A NASA Fact Sheet about sonic booms.
http://www.dfrc.nasa.gov/PAO/PAIS/HTML/FS-016-DFRC.html

General Sound Web Sites

A web site for students to explore sounds, which includes activities, discussions, sound cards and more.
http://www.sci.mus.mn.us/sound/nocss/top.html

"The Quivering Bundles that Let Us Hear" is a starting point for understanding how people hear sound. http://www.hhmi.org/senses/c/c110.htm

Percussion Instruments

Listen to a percussion band at this site!
http://members.nbci.com/LouPanic/home.htm

Sonar (Sound Navigation and Ranging)
Learn how sonar is used to hunt for the Loch Ness Monster.
http://www.pbs.org/wgbh/nova/lochness/

Learn how United States Geological Survey scientists use Terrestrial Remote Sensing to map the ocean floor with sonar. http://TerraWeb.wr.usgs.gov/

A database of sounds including whales, dolphins, and navies from around the world. http://hp.vector.co.jp/authors/VA012709/divonsub.nn

A gallery of sounds and images ranging from sonar databases to libraries of sound clips. http://vision.dai.ed.ac.uk/ashley/Sonar/gal.html#mm

Bats

A Science Inquiry Unit
http://avocado.dade.k12.fl.us/projects/bats/index.html

Bat Cave of St. Clair in Jamaica
http://www.torstar.com/rom/batcave/index.html

Bat Cave of Australia http://moneyraptor.com/bats.htm

Books

Leen, Nina: *Images of Sound.* W. W. Norton & Company, December 1977. ISBN 0393088006

Kenda, Margaret, and Williams, Phyllis, and Robinson, Tim: *Science Wizardry for Kids*, September 1992, ISBN 0812047664

Careers

Bat Curator
Computer Programmer
Sales person
Television Reporter
Cameraman
Behavioral Scientist
City Planner
Sonar Technician
Submariner
Geologist

Activities and Worksheets

In the Guide

Vocabulary Crossword Puzzle 55
Students can use this worksheet to create their own crossword puzzle using the key science vocabulary words from the program.

Owl and Mouse Game 56
A game designed to give students an experience with echolocation as they hunt for "prey."

Mapping the Ocean Floor 57
An activity that simulates sonar techniques used to map the ocean floor.

On the Web

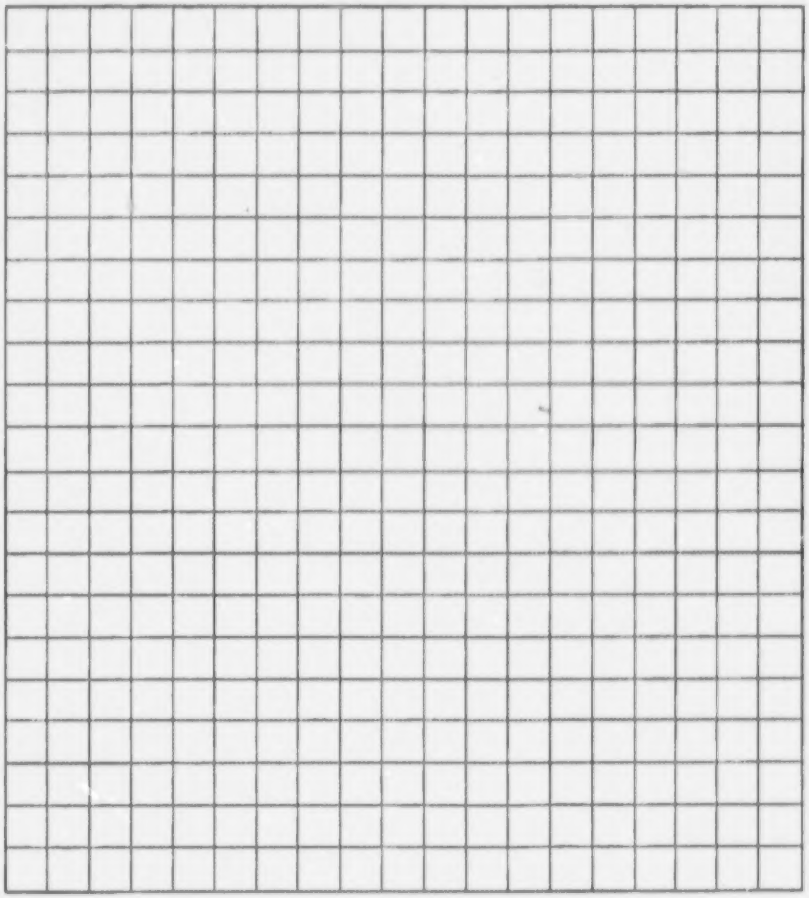
You can find the following activities on the Web at http://whyfiles.larc.nasa.gov.

A Scavenger Hunt, "Surfing the Net"
An activity that gives students an opportunity to perform a web search.

Bats in the Belfry, a Bat Diorama
Students will choose a species of bat and create a diorama depicting the bat's environment, habitat, and lifestyle.

Hot Topics of Sound
A list of topics for students of all grade levels to research and learn more about sound

Vocabulary Crossword Puzzle



Create your own crossword puzzle using the key science vocabulary words from the program.

Vocabulary

devices
echolocation
electric dog repeller
eliminate
internet search
navigate
possibilities
responded
Add your own:

_____
_____
_____
_____
_____
_____

Across

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Down

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Owl and Mouse Game Echolation Activity

Purpose

To give the students an experience with echolocation.

Materials

2 clickers
2 blindfolds

This activity will show how some nocturnal animals such as bats and owls and underwater predators, such as dolphins, use echolocation to hunt their prey. Due to the darkness they incur while hunting, these animals rely on sound. They send out a high-frequency signal, which echoes and enables them to determine the identity of the object and to calculate the distance of the object. This "echolocation" allows animals to hunt in the darkest of environments. This activity will simulate the process.

Procedure

1. Have students stand in a circle and hold hands to create the area or boundary for the game.
2. Choose two students to stand in the middle of the circle with their backs to each other. Explain that one of the students will be the owl (predator) and the other will be the mouse (prey).
3. Tell the students that they will be blindfolded and give them each a clicker. Explain that the owl is to click the clicker, and when it clicks, the mouse will click his clicker in return. The owl will use the sound of the mouse's clicker to locate him. However, the mouse can move away from the owl as long as he stays within the perimeters of the circle. If the owl or mouse bumps into the students standing in the circle, the students should gently guide them back to the center of the circle. Students standing should be quiet.
4. Blindfold both students and hand each a clicker.
5. Let the game begin.
6. Continue until the owl finds or captures the mouse. When the mouse is captured, he should squeak loudly to inform the owl that he has caught his prey.
7. Repeat with other students taking turns as the owl and mouse.

Conclusion

1. Why was it difficult for the owl to find the mouse?
2. What could make it less difficult?
3. How would the fastness of the clicks affect the owl's ability to locate the mouse?
4. Explain how echolocation helps predators to find their prey.

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Mapping the Ocean Floor (Sonar)

Purpose

To simulate the mapping of the ocean floor with sonar techniques.

Using a new type of sonar called Sea Beam, scientists are making better and more detailed maps of the ocean floor. Sonar is the use of sound waves to detect ocean bottom features. From the bottom of a ship, a sound wave is sent toward the ocean floor. As it bounces off the ocean floor, it returns an echo, which is picked up by a receiving device. The computer on the ship calculates the distance to the bottom by using the speed of sound in water and the time it takes for the sound to be reflected. As the ship sweeps the ocean floor going back and forth across the sea floor, it gathers depth readings that are overlapped to make a detail map. These maps help to locate underwater canyons where fish can be found, to find oil-bearing deposits, and for study by oceanographers.

Materials (per group)

- Shoe box with lid
- Clay or plaster-of-paris (enough to cover the bottom of the shoe box)
- Ruler
- Pencil
- Skewer or long straight stick
- Graphing Chart—Profile of Ocean Floor
- Highlighter/marker

Procedure

Advanced Teacher Prep

1. Prepare the shoe boxes for each group by lining the bottom with clay or plaster of paris. Create shapes with the clay such as mountains, valleys, abyssal plains, and any other desired ocean floor feature. If using clay, let it stand for several days to dry and harden.
2. Draw or tape a grid on the lid of the shoe box by using centimeter squares.
3. At the intersection of each grid mark, poke a hole through the lid so that the skewer can be inserted.
4. Place the lid on the shoe box. It is now ready for use.
5. Before beginning the activity, review with the students how to graph. Go over graphing chart noting the labels of axes, increments of numbers, key, and scale.
6. You may wish to demonstrate a few points.

Mapping the Sea Floor

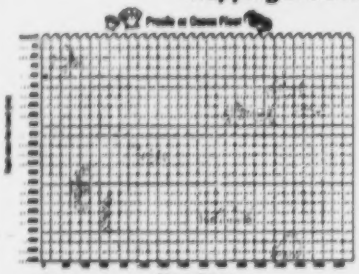

Diagram 1

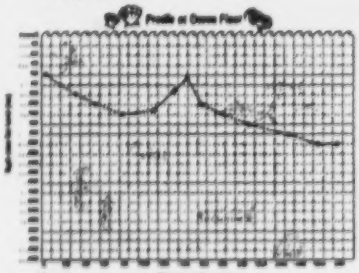

Diagram 2

1. Students will begin by choosing a horizontal (longest) line from the grid on the lid of the box and highlighting that line. This will be the line that they will use to "sound" along to create a cross section of their ocean floor.
2. The edge of the box will represent the shoreline. The students will begin from one edge of the box and insert the skewer perpendicular to the bottom of the box in the first hole along their sounding line. When the skewer stops, lightly mark (with a pencil) the bottom part of the skewer that is remaining above the lid.
3. Withdraw the skewer and measure in centimeters the distance from the end of the skewer that was inserted to the line that you drew.
4. Using the scale (2 cm=200 km), calculate the depth of your first sounding.
5. Plot this point on your graphing chart (p. 58), noting that you are 1 cm from the shoreline. For example: If you are taking your first sounding, you are 1 cm away from the edge of the box. This reading will calculate to 100 km by the scale. If you measure the depth as 3 cm, you will have a depth of 600 km (3 X 200). Now you are ready to plot the point. Go over the bottom to find your distance from shore of 100 km and then go up to your depth of 600 km and mark that point. See diagram 1.
6. Continue to take soundings at each hole along your sounding line.
7. As you plot your points, connect the points to give you a visual profile of the ocean floor. See diagram 2.
8. Discuss the ocean floor profile and determine features, if possible.

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Mapping the Ocean Floor